RECENT BRISK ACTIVITY OF THE CHINESE ELECTRICAL MACHINERY INDUSTRY WHICH IS DEVELOPING BOTH VANGUARD AND ORDINARY PRODUCTS

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Level Greatly Raised Since the Liberation

Genuine development of the Chinese electrical machinery industry has occurred since the time of the first five-year plan. Prior to that there were about 30 electrical machinery enterprises but they could only produce ordinary generators, electric motors, and transformers. During the first five-year plan large-sized electrical machinery plants, steam turbine plants, boiler plants, high-tension switch and rectifier plants, high-tension insulator plants, electricity condenser plants, insulating material plants, electric meter plants, carbon brush plants, and other modern enterprises were built throughout the country, being provided in battle formation. With the 16 years of construction since the birth of the new China, China's electrical machinery industry has accomplished great transfiguration and it has completely extricated itself from the previous backward situation in which the kinds and standards of products of the electrical machinery industry were few, products did not have unit quality, and the majority of raw materials depended on imports from foreign countries. At present, self-supply has become possible for all electrical machinery and equipment considered necessary in various branches of the national economy and the greater part of a number of high-grade, large-sized, precision, and special electrical machinery products. The kinds of products of the electrical machinery industry have more than doubled since 1957 and the quality of products has also advanced remarkably.

In electrical machinery and appliances, quantity production of 50,000-kilowatt thermal electric generator units as well as 72,500-

kilowatt hydroelectric generator units and 5,000-horsepower marine turbines for use in ocean navigation have been manufactured, and it has become possible to produce in quantity transmission and transformer electrical equipment of 220 kilovolts and below. In addition, an electronic static electricity accelerator of several million e v used in atomic energy research and as a source of radiation has been manufactured, and production is being started.

Aside from the new series of products which has greatly developed in medium and small-sized electrical machinery and low-tension electrical appliances, several thousands of altered form products suitable for various climatic, environmental, and use conditions have been born. In addition, electrical equipment has been manufactured which is combined with important products such as automatic argon arc welding machines, shock-wave spot welding machines, and other kinds of new-type welding equipment, vacuum induced electricity furnaces, vacuum self-consumption electric furnaces, hydrogen gas carbon pipe annealing furnaces, 25,000-ton synthetic ammonia equipment, 1,513 m^3 blast furnaces, 1,150 mm lump rolling machines, 4 m^3 excavating machines, 5 m hoists, and mining machinery.

In electric meters, precision meters such as 0.2-class precision meters, 0.02-class precision meters, and 0.1-class medium-frequency experimental equipment are generally combined with general-use electrical machinery products in the country and satisfy requirements for conducting general measurement experiments. In electrical machinery materials, silicom insulating paints, glass-fiber reinforced epoxy resin insulated products, ferromagnetic permanent magnets, precision electric resistance wires, alloy switch points, and many other new-type insulation materials as well as electrical machinery alloy materials are being manufactured, and generally satisfy production demands for electrical machinery products.

Compound Inner Water-Cooled Steam Turbine Generator Unprecedented In the World

In the overall orderly development of all branches of the national economy, the electrical machinery industry is also steadily growing at present. This trend appears in the previously-related large-sized, precision, newly-produced, complicated, high-grade products which are being produced one after the other as well as in the development of production quantity and quality of distributed and practical-use products seen in the increased production of electrical machinery for farm villages. From ultramodern to ordinary items, they are generally trying to quickly catch up to the world level, and among them, some have already surpassed it. For example, the compound inner water-cooled steam turbine generator which directly cools coils of stators and rotors with water has not yet been successful even in the world.

The compound inner water-cooled steam turbine generator is at present the most advanced of the various steam turbine generators. In a generator, coils are wound in the rotors and stators, and when electricity is generated, the leading wire heats up from the great electrical

current. Since the insulation material of the coils can for a long period of time usually withstand a temperature of up to 130 degrees centigrade, when the temperature becomes too high, they burn up. Consequently, this becomes a factor limiting the generator's capacity, and conditions for increasing the capacity of the generator become making the coils with insulating material which withstands high temperatures so that greater electrical current can flow through, improving the cooling method, and making heat radiation of the coils good.

There are inner and outer cooling methods. Outer cooling is also called indirect cooling, and since it cools from the outer surface of the coil insulation layer, the heat radiation effectiveness is not very good. Later, inner cooling was adopted in which the coil leading wire is staggered or it is made with an empty center and the coil is cooled with the wind applied directly to the copper wire. This is much better than outer cooling, and at first the gas used for cooling was air, but later, hydrogen was adopted. Fluid cooling has also been developed for about 10 years, and this uses oil or water instead of gas in cooling. Of air, hydrogen, oil, and water, water has the greatest cooling capability, and if the cooling capability of air is made 1, hydrogen is 12 to 15 and water is 50. The first successful use of inner water cooling in the world was in 1956, and that was with only the stator. Inner cooling of rotors has been discussed in international literature, but since solution of some of the technical problems is difficult, as of now no country has been successful in it except China.

Grappling With World Advanced Technology With Four Years of Experience

In 1958, when the second five-year plan began, it was planned at the Shanghai Electrical Machinery Plant which makes steam turbine generators to within two years trial-manufacture a stator inner water-cooled and a rotor inner hydrogen-cooled type steam turbine generator, catching up with the world top level. At that time, not a few people thought that since China had only a four-year history of manufacturing steam turbine generators and foreign countries had finally arrived at this level after 60 to 70 years, the speed would be considerable if this plan were realized. However, throughout the country the situation of the national economic Great Leap Forward soon appeared, and in it, Chekiang University, in cooperation with the Chekiang Hsiaoshan Electrical Machinery Plant began experimentation on a small-sized generator with rotor inner water cooling and manufactured one small-sized compound inner water-cooled steam turbine generator. Employees of the Shanghai Electrical Machinery Plant also did not wish to follow behind foreign countries. Therefore, they changed their plans and set about design and trial-manufacture of a compound inner water-cooled steam turbine generator and succeeded in making one of 12,000 kilowatts.

After succeeding in trial-manufacture of the first compound inner water-cooled steam turbine generator, employees of the Shanghai Electrical Machinery Plant continued a great amount of experimentation and accumulated definite technological experience. In 1960 they also

manufactured a 100,000-kilowatt compound inner water-cooled steam turbine generator. At present they are considering trial-manufacture of another compound inner water-cooled steam turbine generator which has great generating capacity.

A capacity of 100,000 kilowatts is internationally not so uncommon, but when it is thought that the total generating capacity of the five electric power supply companies in China's largest city, Shanghai, before the liberation did not exceed 250,000 kilowatts and that the 1963 electric power supply capability of the Hong Kong Electric Company was 150,000 kilowatts, it is understood how large it is. Also, success of compound inner water-cooling has great significance for development of the Chinese electric power industry. Hydrogen-cooled generators are better than air-cooled, but since ordinarily their capacity is limited to from 400,000 to 500,000 kilowatts, compound inner water cooling has broken through this limitation and has opened up the road to manufacture of generators of still greater capacity.

Conditions Which Brought About Success of Compound Inner Water Cooling

In designing and trial-manufacturing this generator which is unprecedented in the world, the Shanghai Electrical Machinery Plant encountered very many obstacles. At that time there was no completed technical data, no reference samples, no guidance of specialists, and material and technical conditions were not yet provided. However, they grasped a series of contradictions concerning generator rotor inner water cooling, and with practice, solved many difficult problems one by one.

The Shanghai Electrical Machinery Plant, in the process of designing and trial-manufacture, also carried out the three consolidations of leaders, workers, and technicians, adequately utilizing originality and will of the employee masses. When there were differences of opinion, workers and technicians participated in discussion, and after mutually filling up deficiencies, brought forth a definite plan. Technicians widely sought opinions of the masses concerning technical problems which were difficult to solve. Many of the management and technicians participated in work together with workers, and when a problem was discovered they jointly studied it, disposing of it in good time. In this way, when difficult technical problems once entered the masses and were discussed, they were quickly solved.

In the process of trial-manufacture and trial-operation of the compound inner water-cooled steam turbine generator, several universities and special schools, scientific research organs, and many plants, cooperated closely with the Shanghai Electrical Machinery Plant, utilizing their respective abilities. These units considered solution of problems their own responsibility and devoted all their efforts to this new technology. Such a thing is unthinkable in capitalist countries but is possible in present-day China and is also being conducted widely as a movement.

Some Other New Electrical Machinery Products

Success in manufacture of this compound inner water-cooled steam turbine generator was first announced this year, and it is said that it has already had normal operation for nearly 300,000 hours in 17 powerplants and that the amount of electricity produced has reached more than 3,000,000,000 kilowatt hours. Consequently, it can be said that the fact that its efficiency is excellent has been adequately tested.

In addition, there are the following new electrical machinery products which have been manufactured this year.

100,000-Kilowatt Hydroelectric Generator

The Hsinanchiang Hydroelectric Powerplant no. 4 generator (72,500 kilowatts), the Hsichin no. 1 generator (57,500 kilowatts), and the Chechi no. 2 generator (75,800 kilowatts), have begun generating power, and it has been known that this class could be produced in quantity, but at the beginning of this year it was reported that 100,000-kilowatt hydroelectric generating equipment had been completed at Harbin. The rotor of the water-power turbine is cast from alloy steel, and the principal axis which connects this to the generator is made of 60 tons of forged alloy steel. However, it is not known in what powerplant this generator is being used.

1,500-Kilowatt and 6,000-Kilowatt Gas Turbine Generators

China's first 1,500-kilowatt gas turbine generator unit has been trial-manufactured at the Nanking Turbine Plant since last year. This unit consists of a turbine, gas compressor, combustion chamber, and other accessory equipment, and as a result of trial operation it has been demonstrated that the starting is fast, revolution smooth, it easily withstands change of load, and that it completely meets design requirements. Either light oil, heavy oil, natural gas, or oil gas can be used as fuel. This was made by the same plant in cooperation with the Steam Turbine and Power Research Institute of the No. 1 Machine Industry Department.

Recently, China's first 6,000-kilowatt gas turbine was successfully manufactured at the Shanghai Turbine Plant. The Shanghai Turbine Plant has in recent years manufactured several tens of kinds of steam turbines of various models and outputs, and this 6,000-kilowatt gas turbine which was successfully trial-manufactured was manufactured in a comparatively short time with their own materials. The excellence of its efficiency has been demonstrated by 72 hours of continuous full-load operation. The main body of the gas turbine has a floor space of only about 30 square meters, and it was designed for use as a train powerplant. The gas turbine has the merits of light weight, small volume, and fast starting, and in comparing ordinary gas turbine powerplants with steam turbine powerplants of the same output, the building is small, and the amount of metal material used and basic investment are about half. Operating personnel of the powerplant are also from about one-third to

one-fourth the number. Gas turbines of large output are power machinery which has also recently developed internationally, and successful manufacture of this 6,000-kilowatt gas turbine shows that China's turbine-manufacturing technology has considerably advanced. Recently, by means of exploitation of the Taching oil field, China's oil resources have become very abundant, and it may be noted from that point of view that gas turbines have been trial-manufactured one after the other.

1,000-Kilowatt Back Pressure Turbine

The Hangchou Turbine Machinery Plant has begun small-scale production of a 1,000-kilowatt back pressure steam turbine which can be automatically regulated and which it successfully trial-manufactured. This is China's first, and its sensitivity to automatic control is keen, regulation of the electric power load can be done by remote control, and together with the boiler and generator it can be used as a private powerplant by medium and small-sized light industry enterprises and chemical industry enterprises, and is economical. It was successfully trial-manufactured by the same plant in cooperation with the Steam Turbine Research Institute of the No. 1 Machine Industry Department.

High-Precision Variable Frequency Power Source

China's first high-precision variable frequency power source was successfully manufactured in Shanghai. This can continuously change frequency, one serving the function of several generators. Moreover, electricity generated from this has high frequency stability, strain is very slight, and as compared with ordinary generators it is suitable for efficiency measurement of precision electrical machinery and electric meters. The Shanghai Measuring Standards Control Bureau and specialists of related plants approved the design and manufacture of this power source, and it has been recognized that its precision is at the internationally advanced level, and moreover, its volume is small, structure simple, and cost low.

120,000-KVA Transformer; Movable Large-Sized Transformer

The Shenyang Transformer Plant, China's largest, has manufactured a new 120,000-kva, 220-kilovolt, 3-phase large-sized transformer for generating facilities. Advanced technology has been used in its cooling equipment, insulation material, and oil tanks. Also, the same plant manufactured China's first 15,000-kva, 110-kilovolt movable large-sized tranformer, and delivered it to the railroad branch. Stationary transformers of the same capacity which are presently manufactured in China exceed the height and width limits of steel and girder bridges, and when they are forwarded from the plant, it has been necessary to dismantle them for transport and then reassemble them. The new transformer can be loaded in a specially-made freight car and transported anywhere that railroads go and be quickly used. In addition to its small volume, its resistance to earthquakes is good, and its use and

maintenance are convenient. This was trial-manufactured in response to China's railroad construction needs.

Air Circuit Breaker

The Sian Switch and Rectifier Plant successfully trial-manufactured a 220-kilovolt compressed air circuit breaker of its own design, using domestically-produced materials. Its weight is 11.5 tons, and breaking of the electric current, arc extinction, and circuit reopening, are done in less than one second. Also, at the Shenyang High-Tension Switch Plant, a new type of full air-charging type air circuit breaker for use with 110-kilovolt high-tension transmission lines was successfully trial-manufactured. Ones which have been used in China until now are generally oil circuit breakers, but the action of the air circuit breaker is fast and its capacity is large. When trouble occurs, the power source is automatically cut off within 0.7 second and reconnected within 0.25 second. Oil circuit breakers require 0.9 second in cutting off and connecting. Also, the capacity of the circuit breaker is one-seventh greater than an oil circuit breaker, and consequently, its protection range is much greater. Also, 18 tons of transformer oil can be conserved with one air circuit breaker.

Large-Capacity Silicon Rectifier

The Peking Transformer Plant, in cooperation with the Construction Research Institute of the Metallurgical Industry Department, has manufactured a large-capacity silicon rectifier element and all equipment. This was completed with an investment of only about 100,000 yuan and in about six months. Prior to this, the same plant has manufactured three sets of large-capacity silicon rectifier equipment which have been delivered to and used by metallurgical and transportation branches, and their operational status is good. One of those, the silicon rectifier equipment used for trolleybusses of the Peking Streetcar Company, is of 600V and 1,000A, and its efficiency is four percent higher than a mercury rectifier of the same capacity, and every year about 40,000 KWH of direct current electric energy is conserved, which corresponds to 4,000 yuan (600,000 yen). The degree of automation of the rectifier is also comparatively high, and when trouble occurs, it can automatically change over to a reserve circuit, operating continuously, and even at -30 to -40 degrees centigrade, it functions normally.

The above-related new products were developed as the result of an expanded movement of compare, learn, overtake, and assist, with the three consolidations of workers, technicians, and management, and this has played a great role not only in vanguard products but also in increasing production and raising quality of ordinary products. Especially, the recently-developing product design revolution has produced an independent product system which is technologically advanced, economically rational, and which moreover conforms to China's actual situation.

For example, the Shanghai 51 Electrial Machinery Plant

quarters, parts and manufacturing processes were inferior as compared with the Shanghai Transformer Plant, at the same time periodically exchanging data with 12 transformer manufacturing plants throughout the country, making clear the objectives in each period of its own plant's products reaching the order occupied in the whole country of quality and cost by comparing, learning, overtaking, and assisting. As the result of one year's effort, they caught up with or surpassed the advanced level of Shanghai in more than 100 processes, remarkably increasing the quality of transformers and also reducing cost by nearly 10 percent. However, employees of the plant, never being satisfied with present accomplishments, and based on the experience of last year, organized a group of management, technicians, and workers at the beginning of February of this year, and with 50 key point problems sent them to the Hsiangt'an Electrical Machinery Plant and the Shanghai Transformer Plant, having them work on the spot and study advanced experience. Herein, they not only learned that the total working time required in electric locomotives used by plants and mines and made by their own plant was more than twice that of the Hsiangt'an Electrical Machinery Plant, but discovered that 860 processes, excepting the one process of gear cutting, were inferior. Upon returning, the persons who had gone out to study discussed backward points of the various parts and processes, and made clear the objective to catch up. Since then, they have decided upon concrete steps for overcoming backwardness and are steadily advancing.

Strengthening of Agricultural Assistance and Scientific and Technical Research

Development of the electrical machinery industry has great significance for not only the various branches of industry, but also agriculture. Recently, Chinese agricultural electrification has quickly advanced, and from 1957 to the present, the capacity of electric motors used for agricultural irrigation increased 33 times, and the amount of electricity used by farm villages increased 25 times (80 percent of which is used in agricultural production) (Chungkuo Hsinwen, 25 September, an article by Chuan Tso-i, Head, Water Resources and Electric Power Department). For the electrical machinery industry which is "facing" the farm villages, similarly to other branches of industry, farm villages are a large market, and cannot be neglected. China's electrical machinery industry in addition to supplying a large amount of farm village hydroelectric generating equipment, transmission and transformer equipment, electric power irrigation equipment, and agricultural by-products processing equipment in support of agriculture, has also in recent years increased production of products urgently needed in agriculture, forestry, livestock raising, by-products, and the fish industry, such as electric-powered pumps, electric-powered plows, electric saws, electric hair-clippers, milk separators, electric locomotives for forestry use, and electric-powered equipment for fishing vessel use.

Also, for the purpose of strengthening agricultural assistance, several hydroelectric generating equipment manufacturing plants have

has conducted three revolutions in design of electric motors. Production of alternating-current electric motors at this plant developed suddenly several years ago, but compared with advanced products within and without the country, they still had the defects that production efficiency was relatively low, weight great, and cost relatively high. For the purpose of changing this backward situation, the 51 Electrical Machinery Plant in 1960 conducted its first product revolution. Reforming the backward aspect of their own product as constrasted with the product of the internationally advanced level, they succeeded for the first time in China in improvement of the J02-type electric motor. The total weight of the product after reform was reduced by more than 80 kilograms, and the gap with the internationally advanced level was reduced. With this success, employees of the 51 Electrical Machinery Plant thought this was adequate, and during the next four years did not greatly improve the product, and indeed the level of capacity and weight fell behind the international index. Moreover, since during this time, the international level of electrical machines also newly developed, production of the 51 Electrical Machinery Plant fell further and further behind. Taking a certain model number of a four-polar electrical machine as an example, the product of the 51 Electrical Machinery Plant had a capacity of only 17 kilowatts, but the international advanced level had already reached 22 kilowatts, and the 22-kilowatt electric motor of the 51 Electrical Machinery Plant was 40 kilograms heavier than the internationally advanced product. Users were very dissatisfied concerning the fact that the product of the 51 Electrical Machinery Plant continued to remain at the level of the 1950s. Thereupon, in 1964 they conducted the second product revolution. Increasing from the previous 17 kilowatts to 22 kilowatts the capacity of the four-polar electric motor with a core height of 180 mm, and reducing the weight by 51 kilograms, the international advanced level was reached. This time, employees of the 51 Electrical Machinery Plant, not being satisfied with that result, and studying the report of Premier Chou En-lai to the Third People's Representatives Conference, noticed that the two design revolutions accomplished so far had stopped at only "catching up" to the international level, and that there had not been the great volition to "surpass" the international advanced level. Thereupon, this year they conducted the third design revolution. In 2½ months, they succeeded in designing motors of still greater output and still less volume. In one of these, with a core height of 160 mm, the capacity was increased from 10 kilowatts to 17 kilowatts, and in another with a core height of 180 mm, the capacity was increased from 22 kilowatts to 30 kilowatts. Important technical characteristics of these products, such as weight and capacity, all surpass international advanced products of the same type.

Also, taking the Changchou Transformer Plant as an example, this plant, gathering together and applying last year's experience, continued to develop a movement of compare, learn, overtake, and assist, and it has also recently raised the quality of three kinds of transformers to the level of first-class products. Last year, the Changchou Transformer Plant investigated the points wherein in each of the four

experimentally established service stations, providing technical service for farm village electrical equipment. Farmers are also delighted that many services are being provided in the fields of complete provision of equipment, installation, technical guidance in operation, technical training of supervisory personnel, and expansion of repair of existing equipment.

China's scientific research work in the electrical machinery industry is also advancing rapidly. In addition to the overall research institutes and laboratories established in such places as Peking, Shanghai, and Canton, research organs are being established within the various specialties. For the past several years, various research units, earnestly carrying out the policy in their scientific research of "facing industry and serving industry," have expedited development of production and technology. They have made a great contribution in such fields as electrical machinery cooling technology, high-tension technology, vacuum metallurgy technology, new welding techniques, products for damp and torrid regions, new types of electrical machinery materials, and new insulation materials, Along with development of scientific research, a research experimental base has also gradually been established, and a scientific research camp embracing a considerable number has arisen.

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